Geochemical and hydrological characterization of shallow aquifer water following a nearby deep CO_2 injection in Wellington, Kansas

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Water quality degradation via salinization or CO_2 leakage from local Enhanced Oil Recovery (EOR) or sequestration projects has become a possible source for contamination for local irrigation or potable well users in Wellington, Kansas. Shallow domestic and monitoring wells as well as surface water samples collected from the site were analyzed for a wide array of geochemical proxies including major/trace ions, rare earth elements (REE), stable isotopes, dissolved organic carbon and dissolved gases; these analytes were employed as geotracers to understand the extent of hydrologic continuity throughout the Permian and Cambrian-Mississippian systems. Previous research by Barker et al. (2012) laid the foundation through a mineralogical and geochemical investigation of the Arbuckle injection zone and overlying caprock integrity which led to the conclusion that the 4,910-5,050' interval will safely sequester CO_2 with high confidence of a low leakage potential. EOR operations using CO_2 as the injectant into the Mississippian 3,677-3,706' interval was initiated in Jan 2016 in concomittance with groundwater sampling events; waters were initially tested on the basis of CO_2 leakage contamination. Results indicate that based on Br/Cl mixing relationships, three domestic wells, one monitoring well and one Mississippian oil well plot $3.49e^{-3} \pm 4.2e^{-4}$ with ratios that range $2.72e^{-3}$-$4.87e^{-3}$. $\delta^{18}O$ and $\delta^{2}H$ ranged -4.74 to –5.41 and -31.4 to -34.3, respectively among the domestic wells and shallowest monitoring well. Arbuckle $\delta^{18}O$ and $\delta^{2}H$ values were increasingly enriched relative to shallower samples with Mississippian and surface water samples among the most enriched. Conservative ion relationships of drill-stem-test waters from Arbuckle and Mississippian injection zones displayed significant variability indicating limited vertical hydrologic communication. REE signatures show a consistent Ce-depletion and Eu-enrichment trend among the domestic wells to varying magnitudes with a single domestic well showing a significant positive Eu anomaly indicating equilibrium with a different geologic unit in this region.